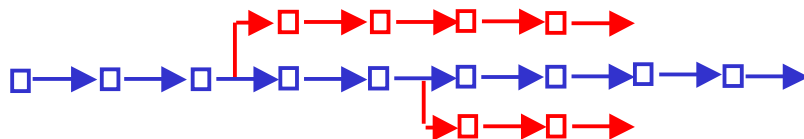


Limited Contingency Planning for Concurrent Activities

David E. Smith

Nicolas Meuleau, Sailesh Ramakrishnan, Betty Lu

Richard Dearden Rich Washington



Motivation

Visual servo (.2, -.15)

Dig(5)

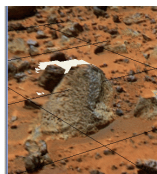
Drive (-1)

NIR

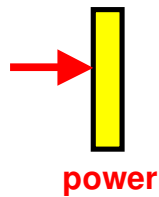
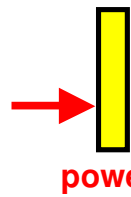


K9

Reality



?



Visual servo (.2, -.15)

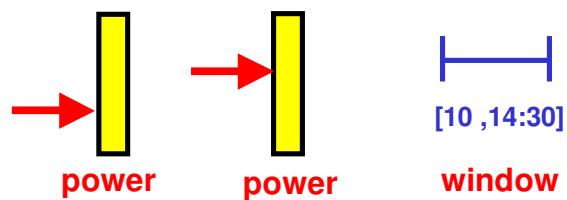
Dig(5)

Drive (-1)

NIR



Better Science Return



data



[10,14:30]



Why Contingency Planning ??

Limited onboard processing

CPU, memory, time

Safety

sequence checking

Anticipation

setup steps



Technical Challenges

Planning under Uncertainty

Classical contingency planning

CNLP, Buridan, Cburidan, Cassandra, SGP, Cplan, ...

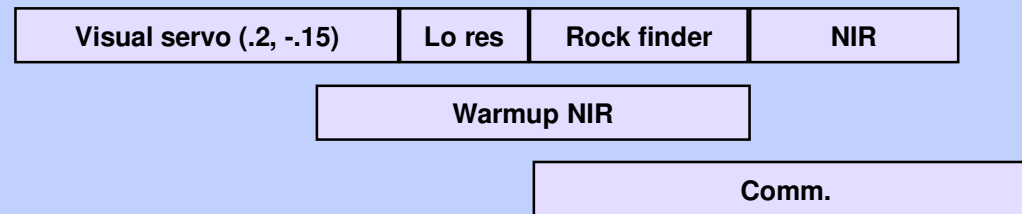
MDP planning

Oversubscription

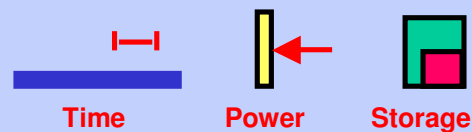
$G_1, G_2, G_3, G_4, \dots$

$V_1, V_2, V_3, V_4, \dots$

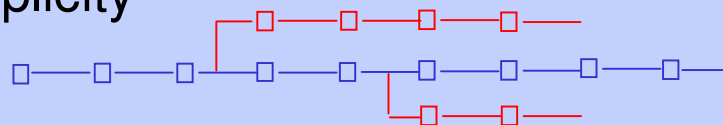
Concurrent overlapping activities



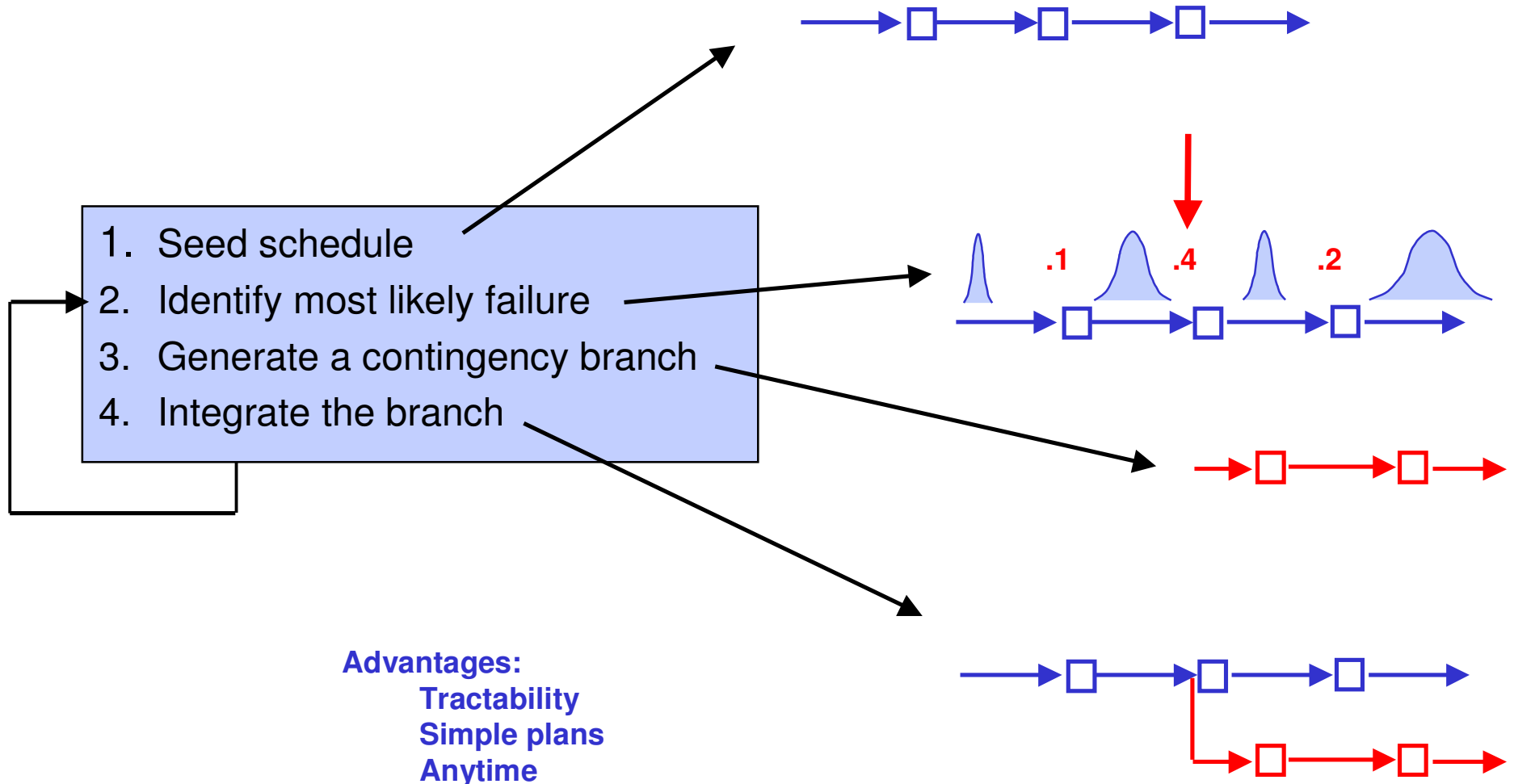
Continuous time and resources



Cognitive simplicity



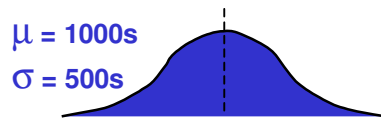
Just in Case (JIC) Scheduling



The Seed

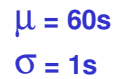
Assume $\Delta t = \mu$

t=13:35



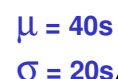
Visual servo (.2, -.15)

t=13:52



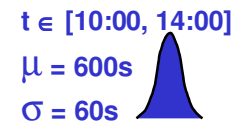
Dig(60)

t=13:53



Drive (-2)

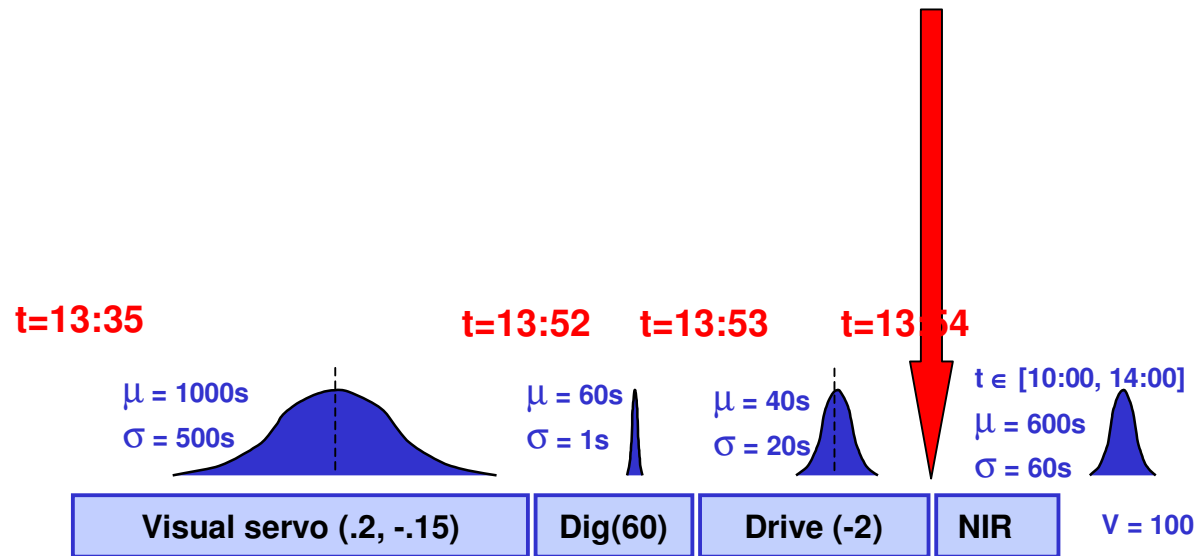
t=13:54



NIR

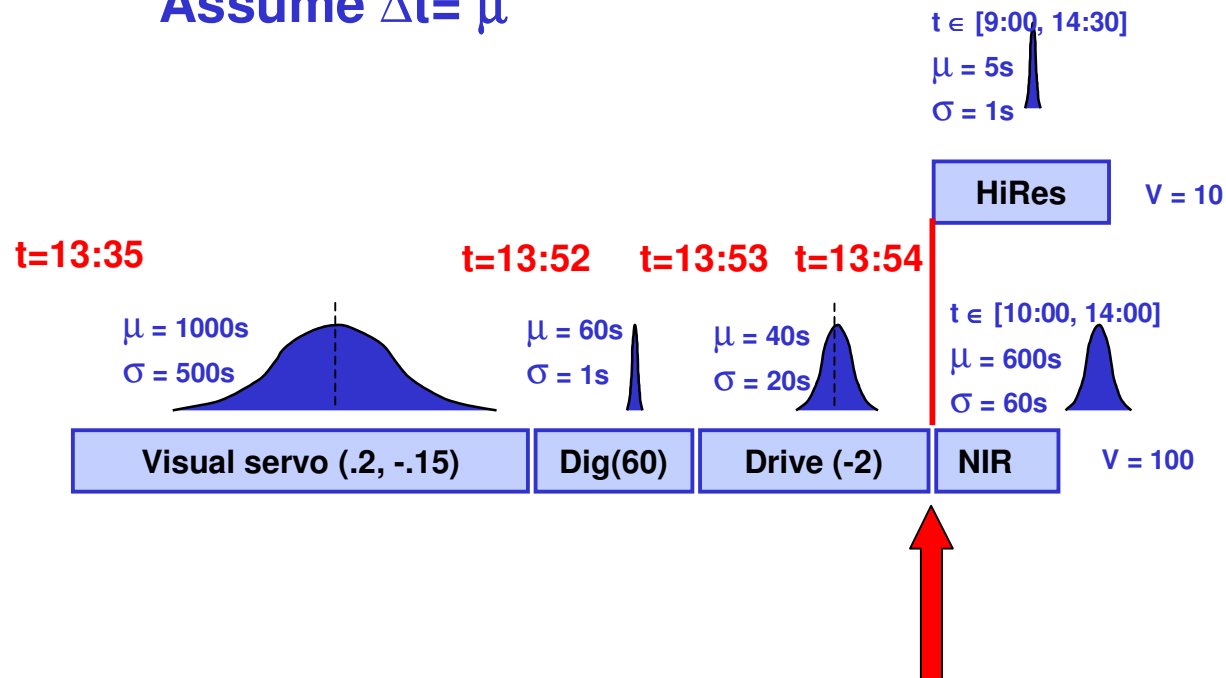
V = 100

Failure Point

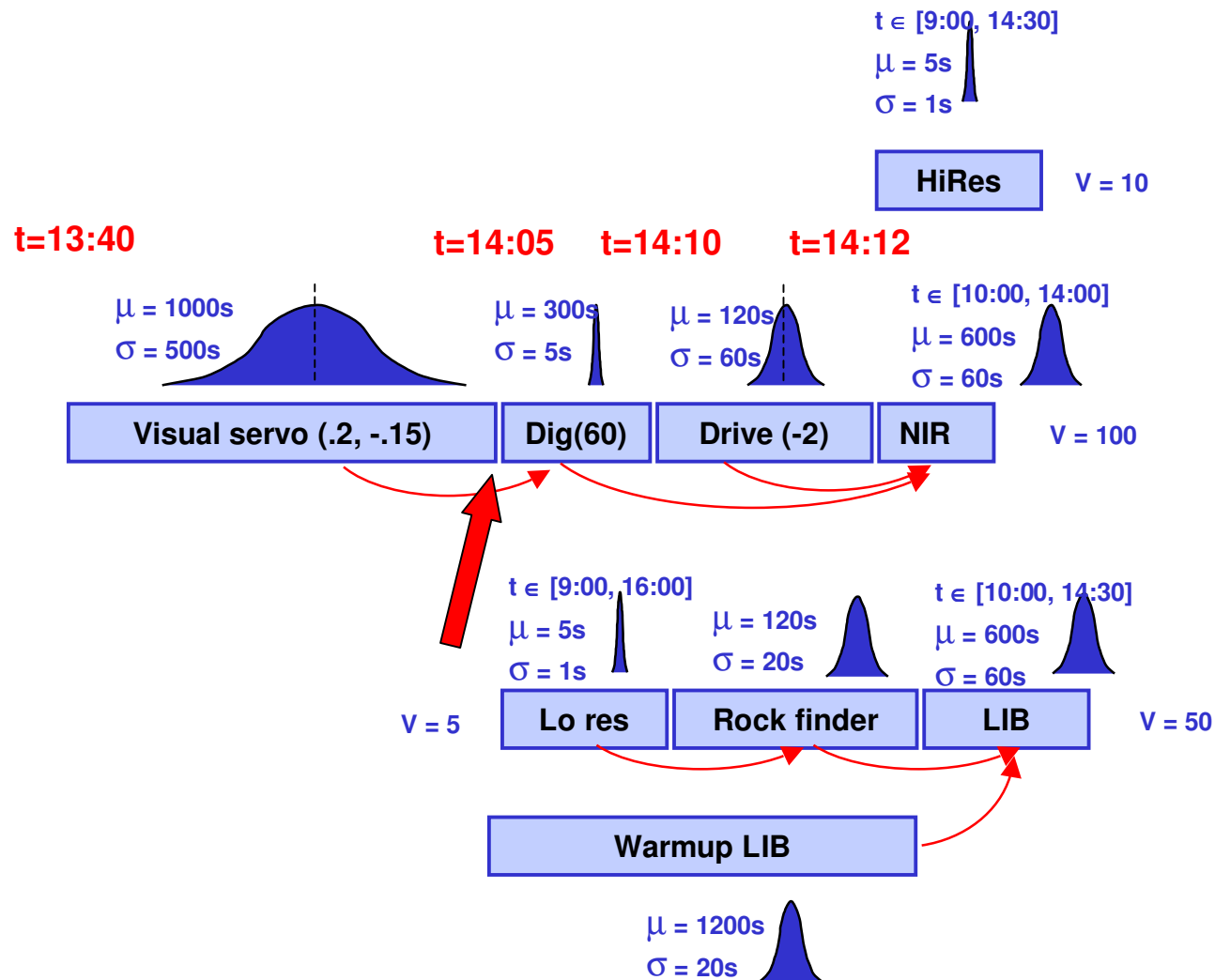


Failure Point

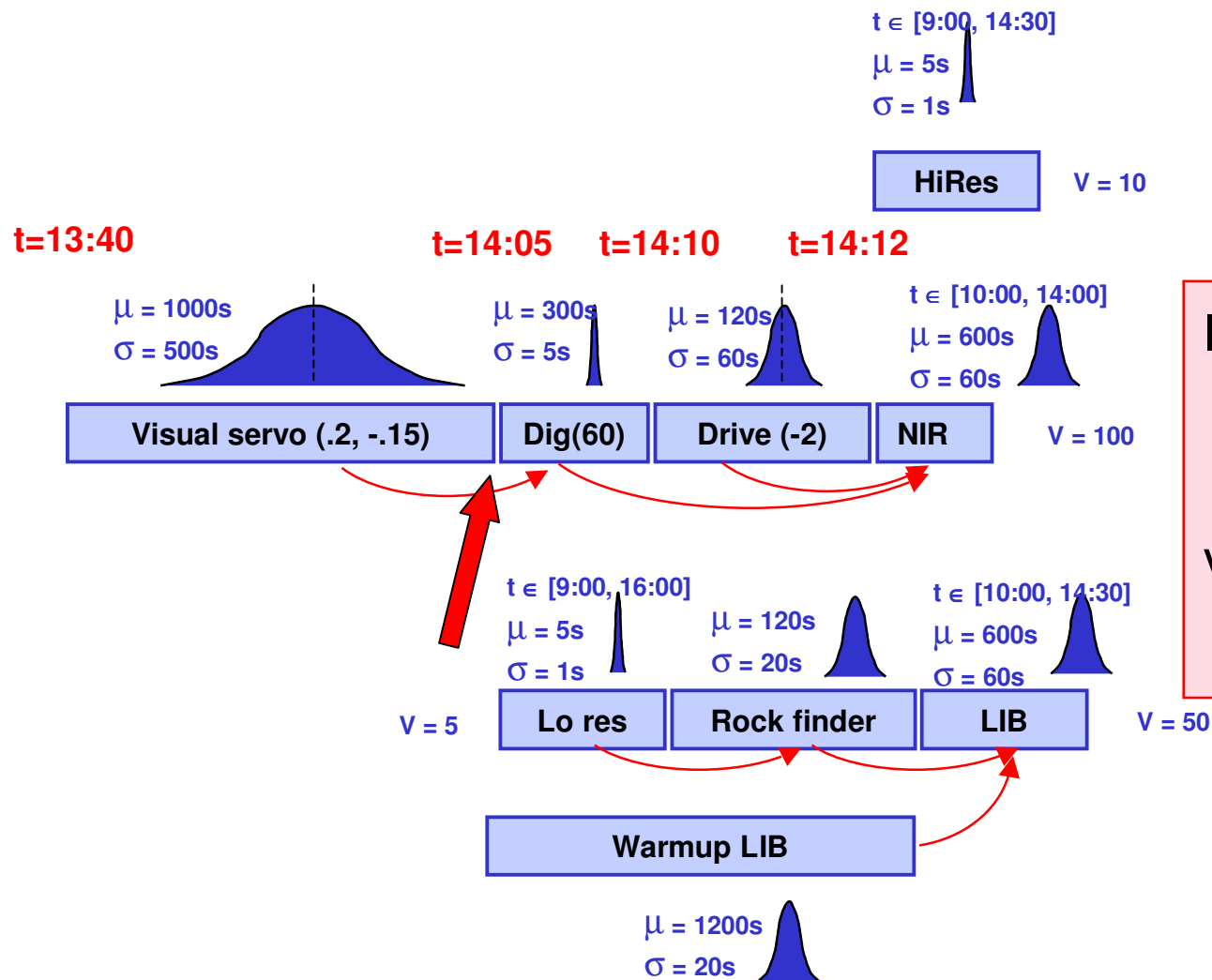
Assume $\Delta t = \mu$



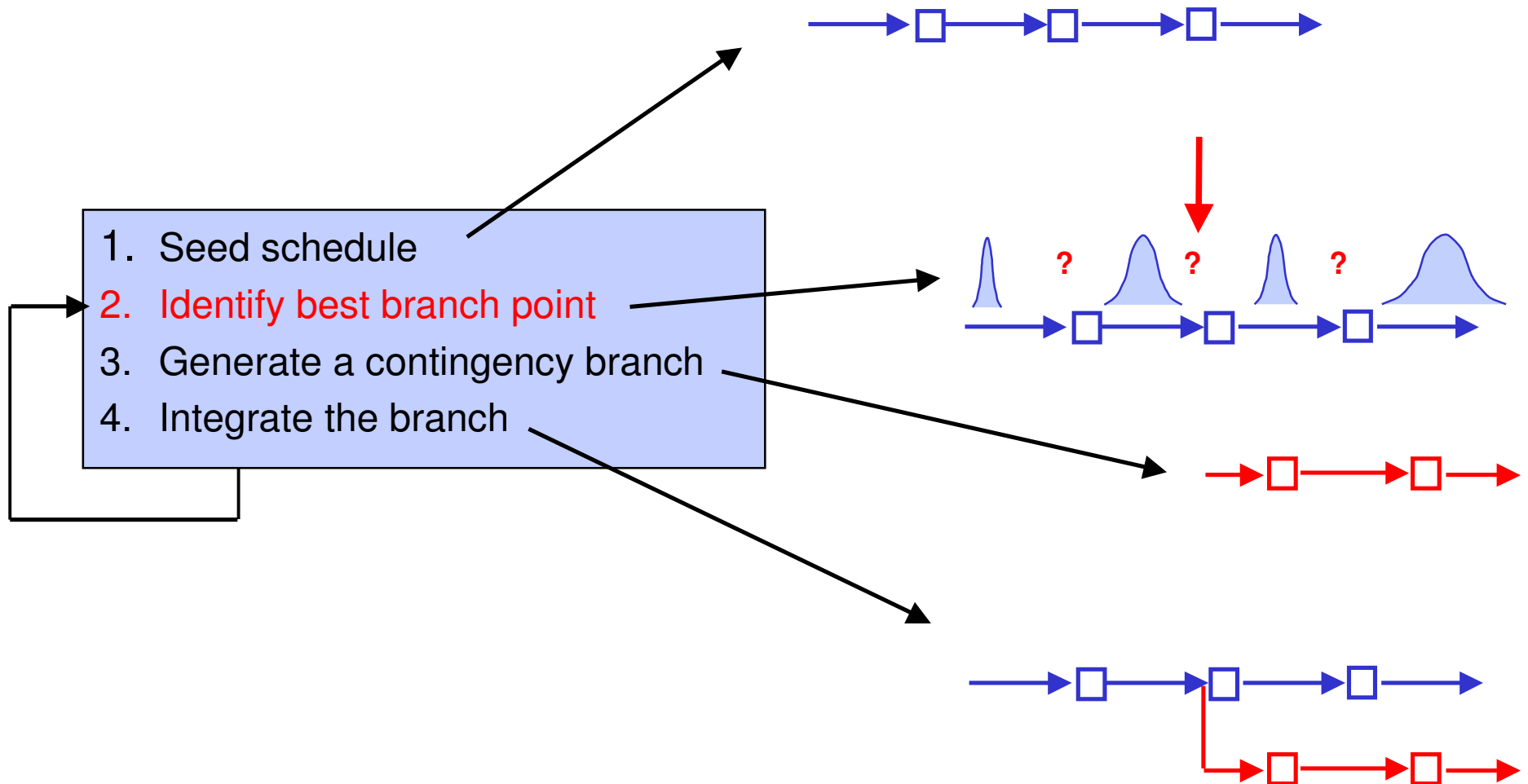
Where the Branch *Should* Go



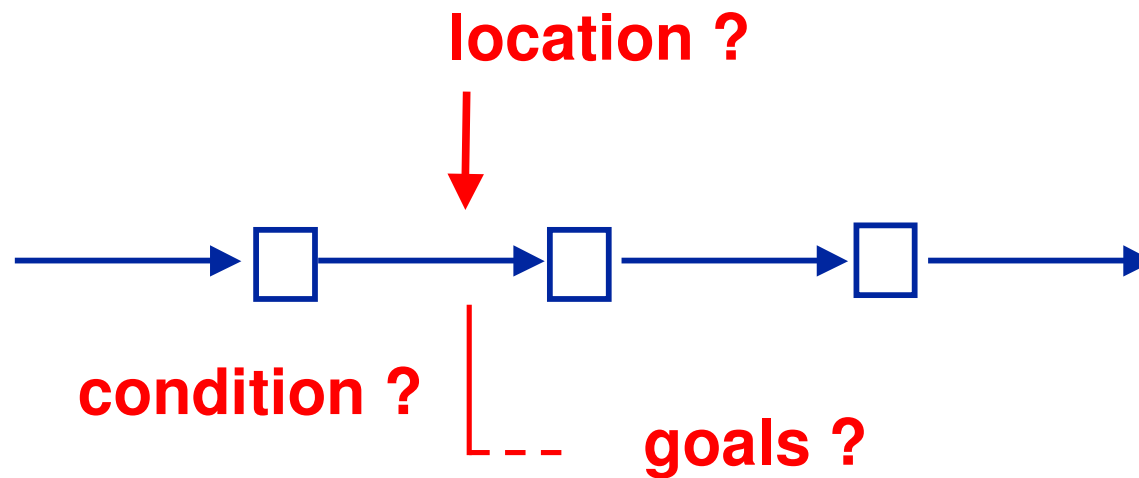
Why ?



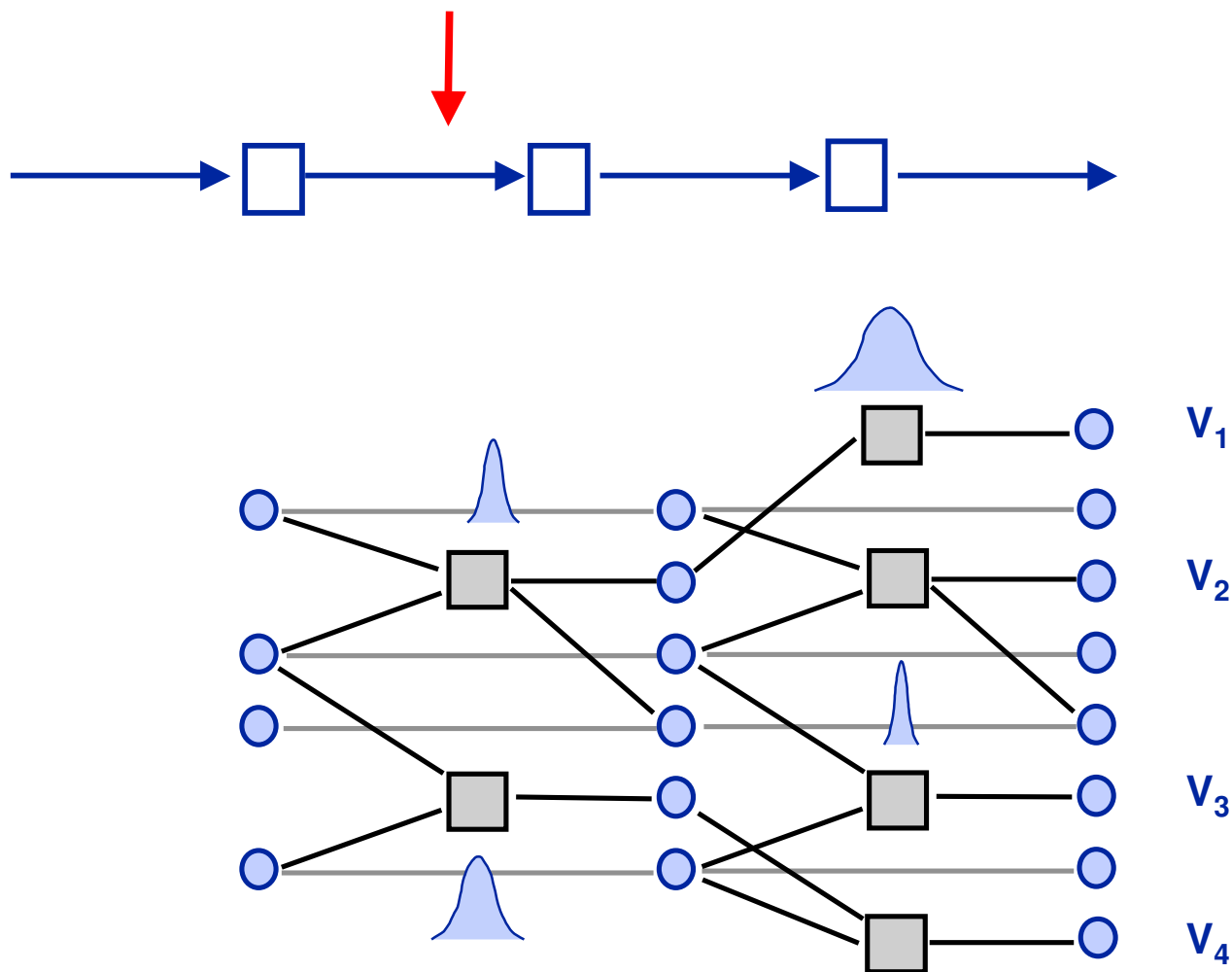
Just in Case (JIC) Planning



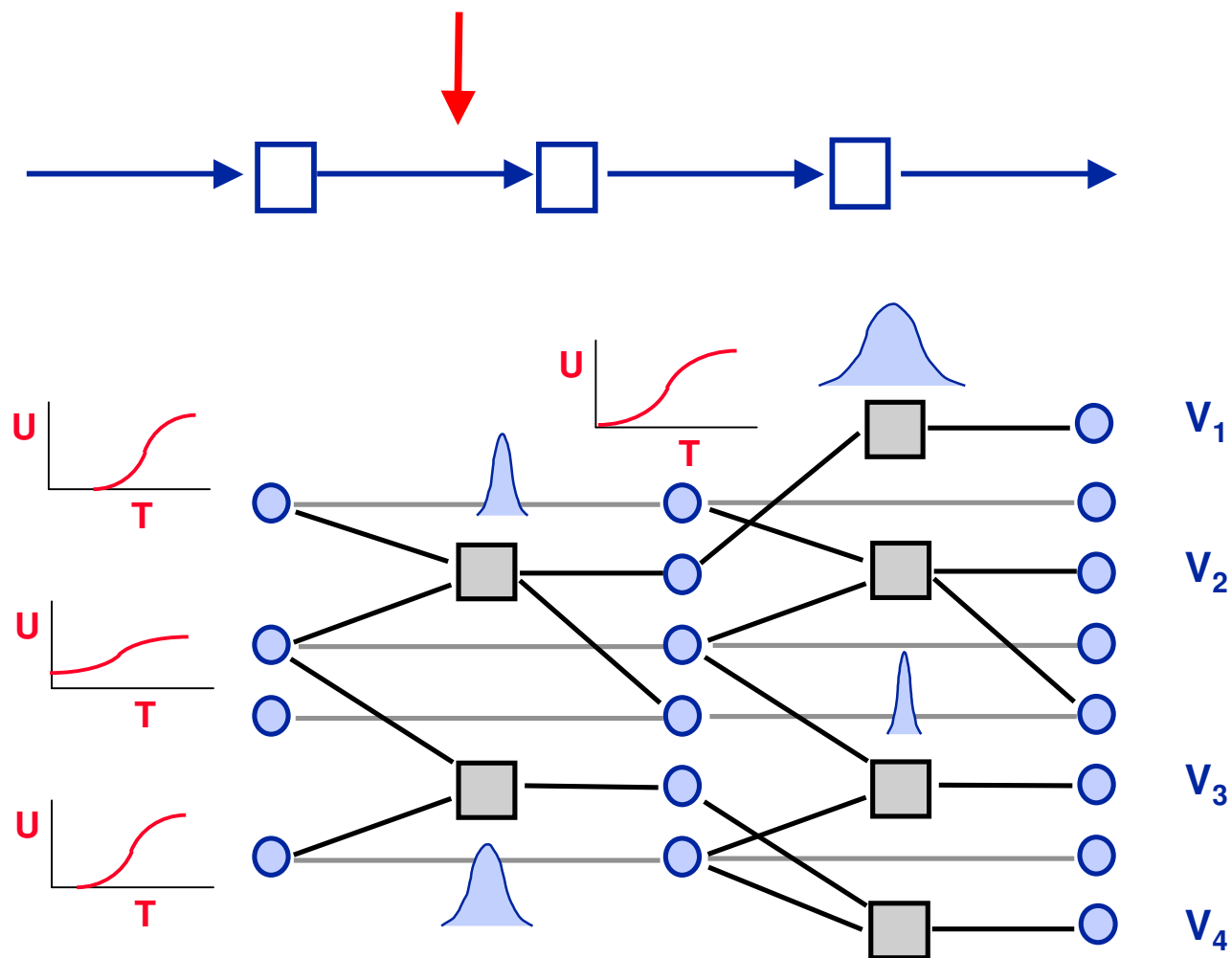
Identifying Good Branches



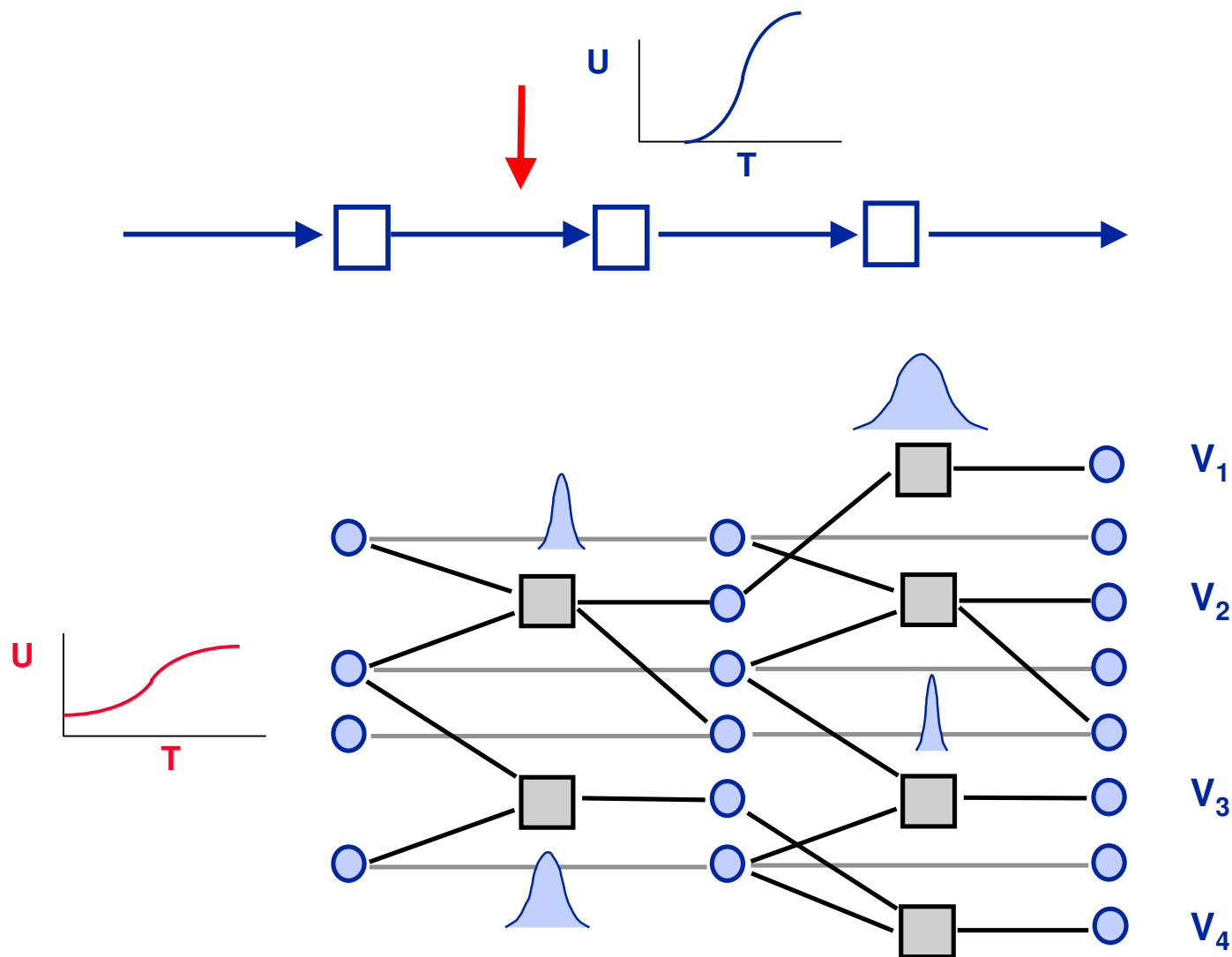
Estimating Utility



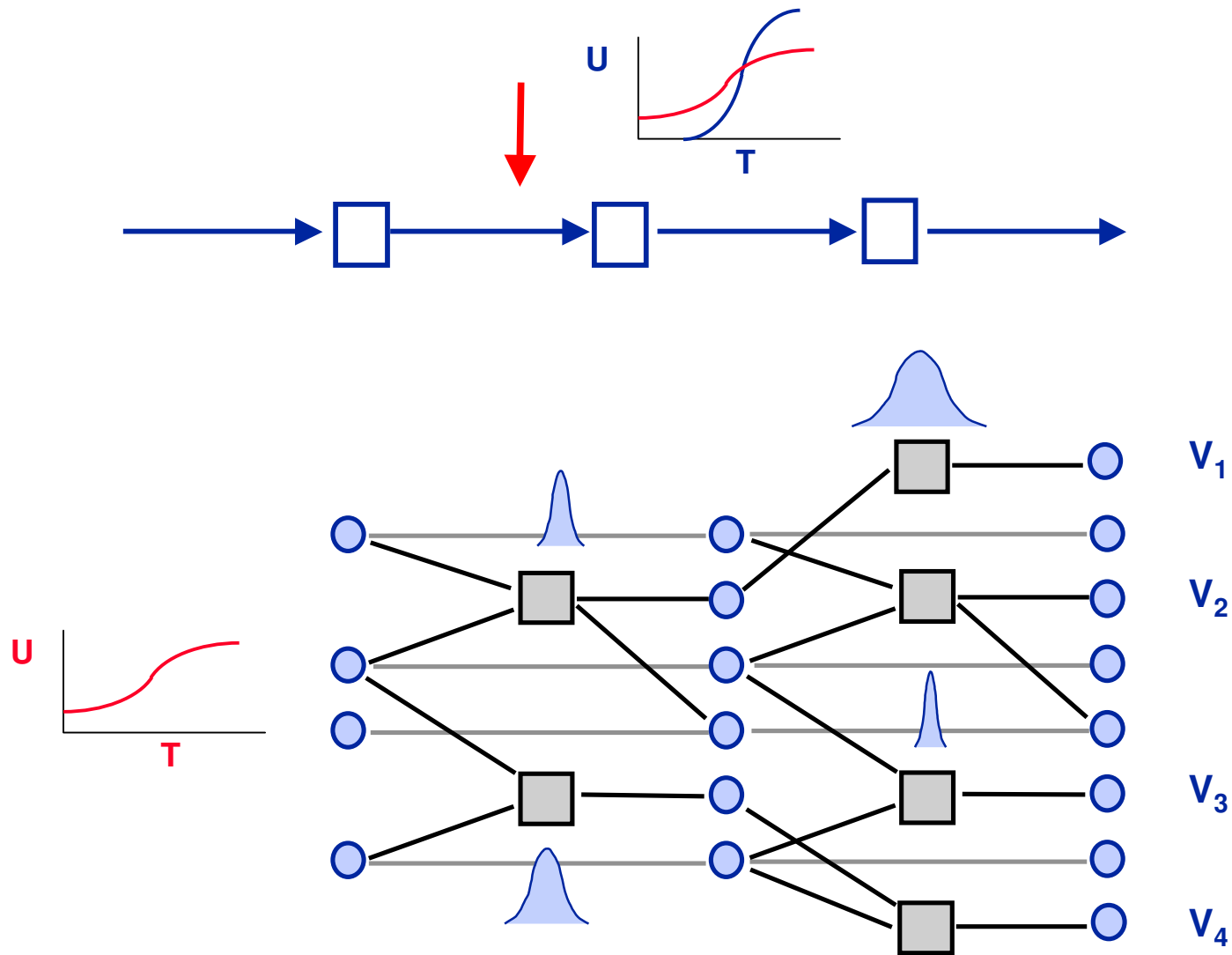
Estimating Utility



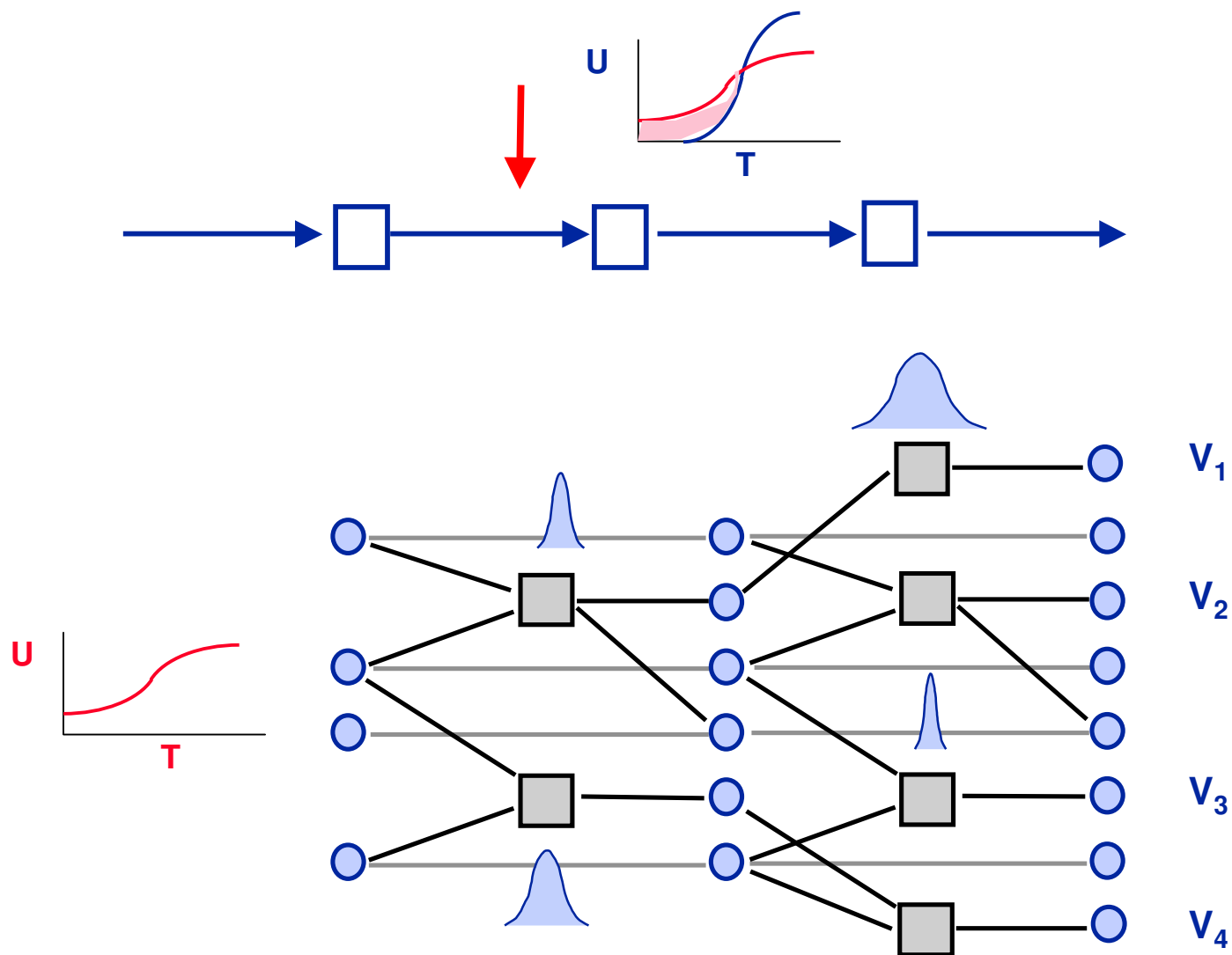
Estimating Utility



Estimating Utility



Estimating Utility



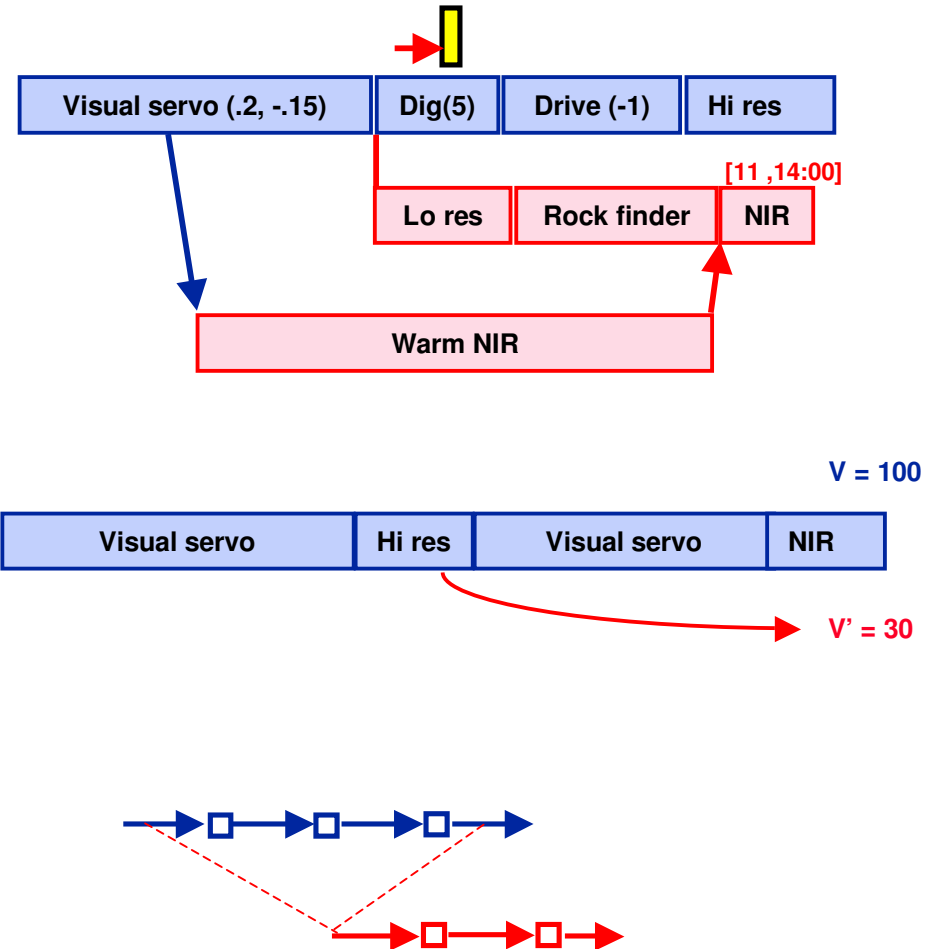
Issues

Setup steps

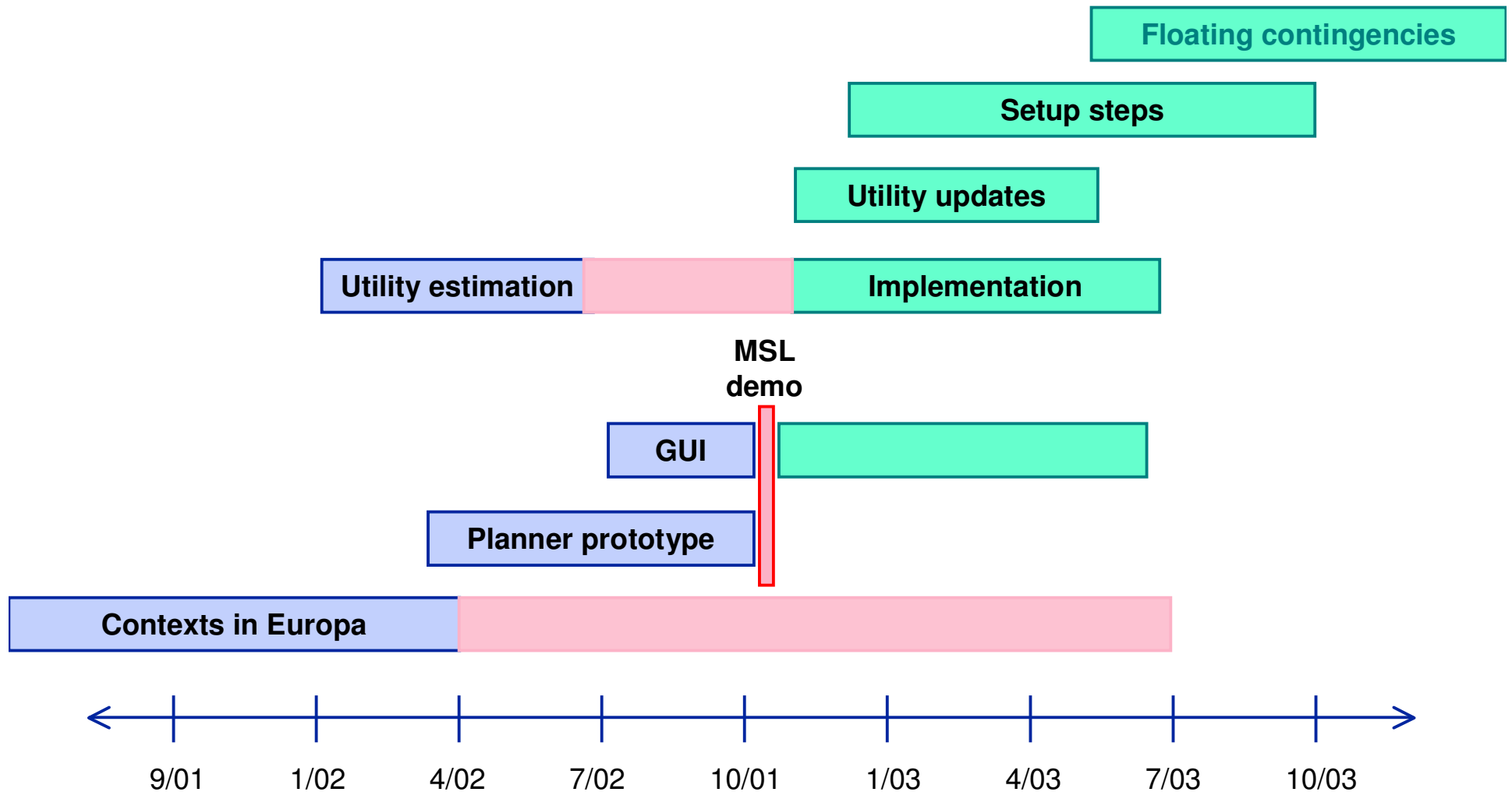
Changing utilities

Sensor costs

Floating contingencies



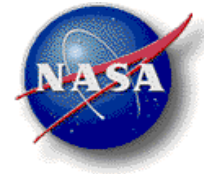
Status





Limited Contingency Planning for Concurrent Activities

D. Smith, N. Meuleau, S. Ramakrishnan, B. Lu, R. Dearden, R. Washington



Goal

Develop contingency planning software for generating more robust mission operation plans

Technical Challenges

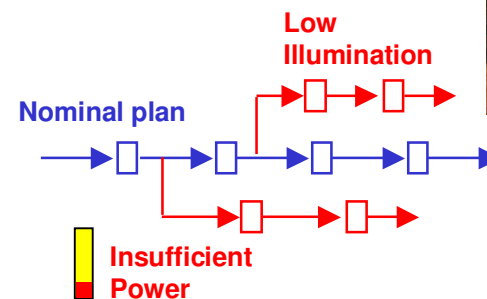
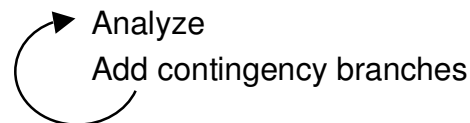
- Continuous quantities (time, resources)
- Concurrent overlapping activities
- Goal oversubscription
- Cognitive simplicity

Key Innovations

- Incremental constructive approach
- Utility estimation
- Goal selection

Description

Plan based on expectations



NASA Relevance

Potential increases in science return for a variety of missions including:

- Mars Smart Lander (2009)
- Comet nucleus sample return

Accomplishments

- Prototype contingency planner using Europa
- GUI for branching timelines
- New approach to
 - branch utility estimation
 - branch condition selection
 - goal selection

Status

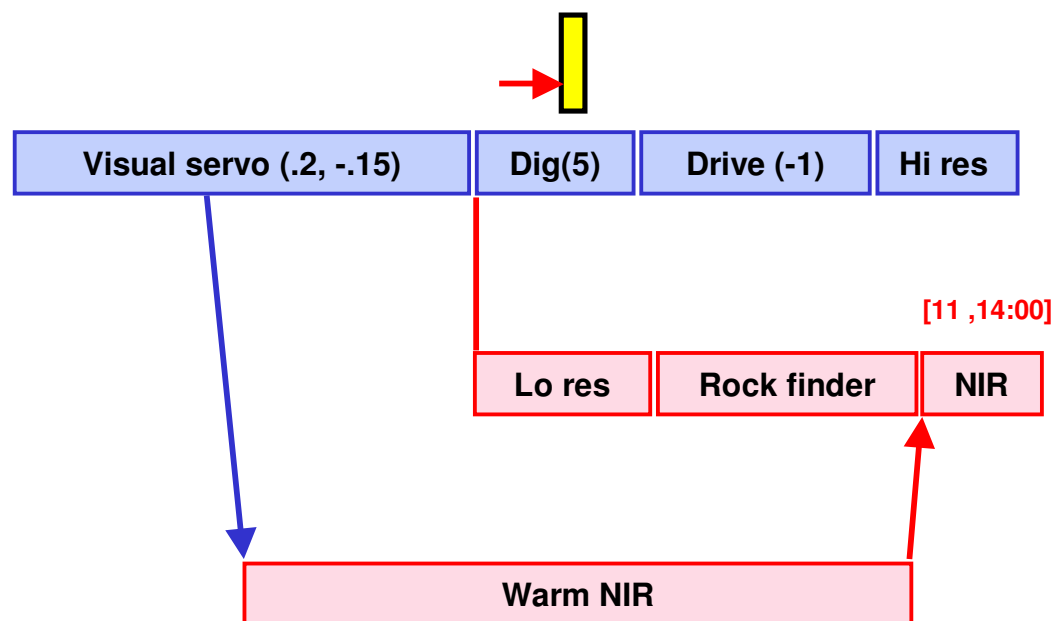
FY02

- Prototype contingency planner using Europa
- Prototype GUI for contingent timelines

FY03

- Integrated demo for MSL program
- Implement intelligent branch selection
- Setup steps

Setup Steps



Optimal Value Function

